(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 334 470 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 89300968.8

(51) Int. Cl.⁴: G03B 3/10

(22) Date of filing: 01.02.89

(30) Priority: 26.02.88 JP 42274/88

(43) Date of publication of application: 27.09.89 Bulletin 89/39

(84) Designated Contracting States: DE ES FR GB NL

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(54) Interchangeable lens devices.

(57) A camera (100) has a main camera body (2) containing a main microprocessor (13), and interchangeable lens devices (1) interchangeably mountable on the camera body (2) and each containing an auxiliary microprocessor (6) storing information identifying the respective lens device (1) and characteristics thereof. Each lens device (1) includes an imaging lens assembly (3) having elements (31, 3i) controllable by drive motors (4) for adjusting respective functions, and the auxiliary microprocessor (6) controls the drive motors (4) in response to position control signals from the main microprocessor (13) and supplies to the latter the stored identifying information and sensed position signals corresponding to the positions of the controllable elements (31, 3i) of the respective lens assembly (3).

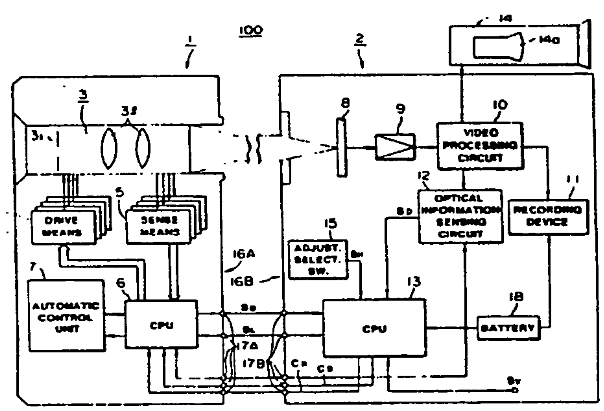

FIG.1

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INTERCHANGEABLE LENS DEVICES

This invention relates to interchangeable lens devices, particularly, but not exclusively, for video cameras, and to cameras comprising such lenses.

Interchangeable lens devices for video and other cameras are well known. It has been proposed, in such cameras, to detect optical information within the camera body and relating for example to focusing or the amount of transmitted light, and to control functions of an imaging lens assembly in the interchangeable lens device on the basis of this optical information, for example, so as to effect auto-focusing and/or automatic exposure control. To achieve such automatic control of functions of the lens assembly, sensors are provided within the camera body for sensing the optical information, whereupon a drive voltage based on the sensed optical information is supplied to the lens device for operating a drive motor by which a function of the lens assembly, such as the focusing or exposure, is automatically adjusted. See, for example, our US patent specifications US-A-4 609 944 and US-A-4 471 383.

In a previously proposed camera in which a drive voltage is supplied from the camera body to an interchangeable lens device for operating a drive motor therein by which a respective function of an imaging lens assembly is adjustably controlled, it is necessary to provide a current conducting path, including respective electrical contacts at an interface between the camera body and the lens device, for each of the several adjustable functions of the lens assembly, for example, for the auto-focusing and automatic exposure control functions. Therefore, as the number of automatic functions is increased, the number of current conducting paths or channels between the camera body and the lens device has to be correspondingly increased, leading to increased size and cost of the camera. Moreover, the characteristics of the drive motors included in the several lens devices intended to be used interchangeably with one camera body may be substantially different, due to differences in the focal lengths or weights of the respective lens assemblies. This makes it difficult to effect the optimum control of the various lens assemblies.

According to the present invention there is provided an interchangeable lens device comprising:

imaging lens means having elements which are controllable for adjusting respective functions thereof;

drive means for each of said functions and operative to drive the respective controllable elements;

characterized by:

sensing means for sensing the positions of said controllable elements established by the respective drive means and for supplying corresponding position information; and

signal processing means operative to control said drive means in response to externally applied position control signals, and to supply sensed position signals to the outside of the lens device in response to said position information.

According to the present invention there is also provided a camera comprising:

an interchangeable lens device including imaging lens means having elements which are controllable for adjusting respective functions thereof, and drive means for each of said functions and operative to drive the respective controllable elements;

characterized in that said lens device further comprises:

sensing means for sensing positions of said controllable elements established by the respective drive means and providing corresponding position information, and first signal processing means operative to control said drive means in response to externally applied position control signals and to provide sensed position signals to the outside of the lens device in response to said position information;

and by:

a main body on which said lens device is removably mounted and including second signal processing means operative to receive said sensed position signals provided by said first signal processing means and to supply said externally applied position control signals to said first signal processing means.

According to the present invention there is also provided a camera comprising:

a main body including an imaging element operative to provide a video signal corresponding to an image projected onto said element, means responsive to said video signal for providing condition sensing signals corresponding to respective conditions of said image projected on said imaging element, manually actuable selector means for providing selected function adjustment signals, and main body signal processing means receiving said condition sensing signal and said selected function adjustment signals; and

interchangeable lens devices interchangeably mountable on said main body and each including imaging lens means for projecting said image onto said imaging element and having elements which are controllable for adjusting respective functions of said imaging lens means, and drive means for each of said adjustable functions and operative to drive the respective controllable elements;

characterized by:

the lens devices further each including sensing means for sensing positions of said controllable elements established by the respective drive means and providing corresponding position information, and auxiliary signal processing means storing information identifying the respective lens device and characteristics thereof, and being operative to supply to said main body signal processing means sensed position signals corresponding to said position information and the stored identifying information; and

said main body signal processing means being responsive to said condition sensing signals, said selected function adjustment signals and said sensed position signals to supply position control signals to said auxiliary signal processing means for causing it correspondingly to control said drive means.

In an embodiment of the invention, each of interchangeable lens device includes an imaging lens assembly having elements which are controllable for adjusting respective functions thereof, for example focusing or exposure control, a drive motor associated with each of these adjustable functions and being operative to drive the respective controllable elements, sensors for sensing positions of the controllable elements as established by the respective drive motors and providing corresponding position information, and signal processing means, such as, a microprocessor or central processing unit (CPU), in the lens device for controlling the drive motors in accordance with externally applied position control signals and for providing sensed position signals to the outside of the lens device in response to the position information from the sensors.

The camera body on which the lens devices are interchangeably mounted may also contain a signal processing means, such as a main microprocessor or CPU, which receives the sensed position signals from the lens device then in use, and provides the position control signals on the basis of such sensed position signals and at least conditions, such as the degree of focusing of, or the amount of light in, an image projected on an imaging element of the camera body by means of the lens assembly. Thus, when the various lens devices are mounted on the camera body, the microprocessor within the lens device which is in use is capable of performing optimum control of the respective lens assembly through the respective drive motors in response to the position control signals from the microprocessor in the camera body, even although the characteristics of the drive motors may differ from one lens device to another.

It is another feature of embodiments of the invention to provide for the optical transmission of the position control signals and the sensed position signals between the camera body and the lens devices interchangeably mounted thereon.

When the invention is applied to a video camera, signal processing in the microprocessors of the camera body and the lens devices, respectively, is facilitated by effecting the transmission of the position control and sensed position signals between the microprocessors of the camera body and the lens device mounted thereon in synchronism with the vertical synchronizing signals, and by operating the drive motors to drive the respective controllable elements of the lens device only during intervals between the successive intermittent transmissions of the position control and sensed position signals.

The invention will now be described by way of example with reference to the accompanying drawings, throughout which like parts are referred to by like references, and in which:

Figure 1 is a block diagram of an embodiment of video camera according to the present invention;

Figure 2A is an elevational view of a mounting surface of an interchangeable lens device into the video camera of Figure 1;

Figure 2B is an elevational view of a mounting surface of a camera body in the video camera of Figure 1;

Figures 3A to 3D are diagrammatic views illustrating the format of signals transmitted in the video camera of Figure 1;

Figures 4A to 4D are timing charts for explaining the timed relationship of the transmission signals between the camera body and the lens device of Figure 1 in respect of vertical synchronizing signals;

Figures 5A and 5B are elevational views similar to those of Figures 2A and 2B, respectively, but illustrating a modified embodiment of the invention; and

Figures 6A and 6B, taken together, illustrate a flow chart to which reference will be made in explaining the operation of the camera of Figure 1.

Referring initially to Figure 1, a video camera 100 includes an interchangeable lens device 1 and a camera body 2 to which the lens device 1 is removably attached so as to be interchangeable with other similar lens devices (not shown). The lens device 1 includes an imaging lens assembly 3 having a plurality of imaging lenses 31, at least some of which are movable relative to the others in the axial direction, that is, in the direction of the optical axis of the lens assembly 3, for adjusting functions of the lens assembly 3. More specifically such relative movements of the lenses 31 in the direction of the optical axis have the function of

adjusting the focus, and/or adjusting the focal length (zooming). The lens assembly 3 has a diaphragm mechanism 3i having movable iris blades (fins) for adjusting the amount of light permitted to pass through the lenses 31, that is, for effecting exposure adjustment or iris control.

The lenses 31 are axially displaced relative to each other for effecting focus adjustment and/or zooming by a mechanism (not shown) responsive to manual rotation of an associated adjustment ring and, similarly, the iris blades are displaced by a suitable mechanism (not shown) in response to manual rotation of an adjustment ring for effecting exposure adjustment. The lenses 31 and the movable elements of the diaphragm mechanism 3i can also be driven and controlled by drive means 4, for example, by respective electric motors for controlling the respective adjustment functions. In other words, individual motors are provided in the drive means 4 for effecting the focusing adjustment, the zooming adjustment and the exposure adjustment, respectively.

Each lens device 1 further includes sensors 5 which sense the positions of the elements controlled or driven by the several motors, respectively, of the drive means 4. Thus, sensors 5 are provided for sensing the positions of the lenses 31 and the movable iris blades by which the drive motors effect respective focus, zoom and exposure adjustments. The motors of the drive means 4 are controlled by a microprocessor or CPU 6 included in the respective lens device 1 and receiving position information from the sensors 5. Moreover, the CPU 6 has stored therein information identifying the respective lens device 1 and the characteristics thereof, for example, information concerning the focal length or aperture of the lens assembly 3 and/or information concerning the motors of the drive means 4.

An automatic control unit 7, for example, of the type employing a focal point sensor, may also be provided in the lens device 1, and is connected to the respective CPU 6 for automatically effecting adjustment of the respective function, for example, for effecting auto-focusing through suitable operations of the motors of the drive means 4.

The camera body 2 includes an imaging element 8, for example, in the form of a charge coupled device (CCD), which is situated at the focal point of the lens assembly 3 of the lens device 1. The imaging element 8 is operative to convert an image projected thereon by the lens assembly 3 into corresponding video signals which are supplied through an amplifier 9 and a video processing circuit 10 to a video recording device 11, such as, a video tape recorder (VTR). The video signals are also supplied from the processing circuit 10 to an optical information sensing circuit 12 which, on the basis of the received video signal, senses the optical condition of the corresponding projected image, for example, the degree of focus and/or the amount of light therein. The sensing circuit 12 provides condition sensing signals SD which are characteristic of those conditions of the image projected on the imaging element 8, and which are supplied to a microprocessor or CPU 13 included in the camera body 2. For sensing or detecting the degree of focus of the image projected on the imaging element 8, the sensing circuit 12 may detect the level of the high frequency component of the video signal supplied by the imaging element 8 as a measure of the focused state. In other words, the level of the high frequency component of the video signal is maximized at the fully focused state of the image projected on the imaging element 8. On the other hand, the amount of light in the image projected on the imaging element 8 may be sensed by the sensing circuit 12 by detecting the level of the video signal, as a whole. The video signal obtained from the processing circuit 10 is further supplied to an electronic viewfinder 14 which includes a CRT 14a at which the image projected on the imaging element 8 can be monitored.

The camera body 2 is further provided with adjustment selector switches 15 which are manually actuable by respective push-buttons 15A (Figure 2B) for supplying selected function adjustment signals SH to the CPU 13. Such selected function adjustment signals or commands are provided, at the operator's option and irrespective of the state of the video signals, and hence of the condition sensing signals SD, for obtaining desired adjustments of the functions of the lens assembly 3, for example, for effecting zooming.

The CPU 13 further receives sensed position signals SS which are supplied by the CPU 6 of the lens device 1 in response to the position information supplied to the CPU 6 by the respective sensors 5. On the basis of the condition sensing signals SD, the selected function adjustment signals SH and the sensed position signals SS supplied to the CPU 13, it produces corresponding position control signals SL which are supplied to the CPU 6 to cause it suitably to control the motors of the drive means 4 for obtaining desired adjustments of the functions of the lens assembly 3. The sensed position signals SS supplied from the CPU 6 to the CPU 13 further contain the information stored in the CPU 6 for identifying the respective lens device 1 and the characteristics thereof.

As shown in Figures 1, 2A and 2B, each lens device 1 and the camera body 2 have mating surfaces 16A and 16B which interface when the lens device 1 is mounted on the camera body 2. Such mating surfaces 16A and 16B are provided

with mutually engageable electrical contacts 17A and 17B, respectively, for each of the signals to be transmitted between the lens device 1 and the camera body 2. The contacts 17A and 17B complete the signal transmission circuits between the CPUs 6 and 13 when a lens device 1 is mounted on the camera body 2.

Vertical synchronizing signals SV which may, for example, be formed from the video signals in the processing circuit 10 are supplied to the CPU 13 which, in turn, supplies a chip select signal CS synchronized with the vertical synchronizing signal SV. The CPU 13 also supplies clock signals CK which, as described in detail below, are transmitted, in synchronism with the chip select signal CS, from the CPU 13 to the CPU 6 through respective engaged contacts 17A and 17B for a purpose described in detail below. An electrical source, for example, a battery 18, is provided in the camera body 2 for supplying suitable electrical power to the CPU 13 and other operating components of the camera body 2, and also for supplying electric power, through respective engaged contact 17A and 17B, to the CPU 6 of the lens device 1 mounted on the camera body 2.

Referring now to Figure 3A, the position control signals SL transmitted from the CPU 13 of the camera body 2 to the CPU 6 of a lens device 1 mounted thereon comprise a control code CC, an address code CA and a first to fourth control data D1, D2, D3 and D4 which total four bytes. The sensed position signals SS transmitted from the CPU 6 to the CPU 13 have a format similar to that of the signals SL with the specific differences mentioned below. The control code CC is formed of eight bits including two page designating bits, one read bit, one write bit, and the data byte number designating bits. Each page designated by the control code CC is divided into four pages P0, P1, P2, P3, as shown in Figure 3B. Each of the pages P0 to P3 is provided with respective read data and write data regions, and each of the pages P0 to P3 is correlatively associated. For example, the page P0 may be reserved for information characterizing the lens device 1, such as, the focal length, aperture ratio, zooming range and/or maker ID number, while the page P1 may be reserved for the position control signal SL or the sensed position signal SS, as the case may be. The page P2 may be reserved for the maker's or manufacturer's special data, such as the lot number and date manufactured, while the page P3 may be reserved for additional data that may be used in the future. The read bit of the control code CC indicates transmission of a sensed position signal SS from the lens device 1 to the camera body 2, while the write bit of the control code CC indicates the transmission of a position control signal SL from the camera body 2 to the lens device 1. The read and write bits respectively designate the read and write data regions of the designated pages. Finally, the data byte number designating bits are the end of the control code CC indicate the number of bytes of the data that is transmitted.

The address code CA of a sensed position signal SS or position control signal SL contains data identifying hexadecimal addresses OOH to FFH as indicated by H, for each of the read and write data regions indicated in Figure 3B. More particularly, the address code CA indicates, by its addresses, the data to be transmitted in the read data region of the case of a sensed position signal SS, or the data to be transmitted in the write data region in the case of a position control signal SL. For example, the address code CA may indicate the transmission of data at the addresses 4OH to 4FH, as indicated in Figures 3B and 3C.

By way of example, if it is assumed that the drive means 4 in the lens device 1 is provided with four drive motors M1, M2, M3 and M4, respectively, associated with respective adjustment functions of the lens assembly 3, and that four of the sensors 5 are provided for sensing the positions of the elements driven by the motors M1 to M4 for adjusting the respective functions, four bytes of control data D1, D2, D3 and D4 at the addresses 40H to 43H constituted the position control signal SL for the first motor M1 or the sensed position signal SS associated with the motor M1. Similarly, four bytes of data D1 to D4 at the addresses 44H to 47H of the write data region constitute a position control signal SL for the motor M2, whereas four bytes of data at the addresses 44H to 47H in the read data region constitute a sensed position signal SS for the same motor M2. Correspondingly, four bytes of data at the addresses 48H to 4BH of the write and read data regions, and four bytes of data at the addressed 4CH to 4FH of the write and read data regions provide position control signals SL and sensed position signals SS for the motors M3 and M4, respectively.

In the write mode, that is, in the case of a position control signal SL, one bit of the data D1 indicates whether the respective one of the motors of the drive means 4, for example, the motor M2 in Figures 3C and 3D, should be operated, one bit indicates the direction in which the drive motor M2 is to be operated, that is UP or DOWN, one bit indicates whether the position to which the drive is to be displaced by the motor M2 in response to the transmitted position control signal SL is indicated in absolute or relative terms, and four bits indicate the speed with which the respective motor M2 is to be operated. The sixteen bits of the third and fourth bytes of the control data D3 and D4 indicate the position to which the motor M2 is to displace the

respective element of the lens assembly 3 for achieving the desired adjustment of the function of the lens assembly 3 in response to the transmitted position control signal SL. The byte of data D2 represents a reserve or spare data region.

In the read mode, that is, in the case of a sensed position signal SS, the last four bits of the data D1 (which indicate the drive speed in the case of a position control signal SL) are employed to represent the bit number, and hence the adjustment accuracy, of the data D3 and D4, and hence the accuracy with which the respective function of the lens assembly 3 in the lens device 1 can be adjusted.

Transmission of the signals SS and SL between the CPU 6 in the lens device 1 and the CPU 13 in the camera body 2 is preferably synchronized with the vertical synchronizing signals SV derived from the video signals in the processing circuit 10. More particularly, as shown in Figure 4B, the chip select signals CS are supplied by the CPU 13 in synchronization with the vertical synchronizing signals SV (Figure 4A), and the position control signals SL and the sensed position signals SS are transmitted between the CPUs 6 and 13 only during the chip select signals CS, as shown in Figure 4D. Moreover, as shown in Figure 4C, the reference clock signal CK is also transmitted in synchronism with the chip select signals CS.

When the signals SL and SS are transmitted between the CPUs 6 and 13 only during the chip select signals CS, the CPUs 6 and 13 only need to monitor whether the signals SL and SS are being transmitted during the periods of the chip select signals CS. During the intervals between the chip select signals CS, the CPUs 6 and 13 are free to effect control of the motors of the drive means 4, and to effect the arithmetic operations based on the previously transmitted signals. This simplifies the software that is required and reduces the labour involved in programming and/or debugging. Also, the signal processing speed is increased and the timing of the signal transmission is clearly defined, so that signal transmission errors can be readily detected and more accurate signal transmission can be achieved.

Referring now to Figures 5A and 5B, in a modified embodiment of the invention, the electrical contacts 17A and 17B provided for transmitting the various signals between the CPUs 6 and 13 in the embodiment of Figures 1, 2A and 2B, are replaced by an optical transmission arrangement. More specifically, in the embodiment of Figures 5A and 5B, the mating surface 16′A of the lens device 1′ is provided with a light emitting element 19A and a light receiving element 20A, and the corresponding or mating surface 16′B of the camera body 2′ is provided with a light emitting element 19B and a light receiving element 20B. When the surfaces 16′A and 16′B mate with each other upon mounting of the lens device 1′ on the camera body 2′, the light emitting element 19A registers with the light receiving element 20B for forming a so-called photo-coupler therewith, and the light emitting element 19B similarly registers with the light receiving element 20A for forming another photo-coupler therewith. The light emitting elements 19A and 19B emit light in a pulsed manner in accordance with the transmitted sensed position signal SS and position control signal SL, respectively, and the light thus emitted is received by the light receiving elements 20B and 20A, respectively, for transmitting the signals SS and SL to the CPUs 13 and 6, respectively, in the camera body 2′ and the lens device 1′. Optical signal transmission, as described with reference to Figures 5A and 5B, is effective to avoid signal transmission errors that may occur due to poor electrical contact or shorting when effecting electrical transmission.

The operation of the video camera 100 will now be described with reference to the flow chart of Figures 6A and 6B. Upon the initiation of the automatic control of the camera 100 in the step (101), the program of the CPU 13 advances to the decision step (102) in which it is determined whether or not a lens device 1 is mounted on the camera body 2. If so, the program moves to the step (103) in which the CPU 13 issues a call for the transmission to it of the initial data from the CPU 6 in the lens device 1. In response to such call, the CPU 6 is made operative in the next step (104) to transmit to the CPU 13 the initial data stored in the CPU 6, and which identifies the respective lens device 1 and the characteristics thereof. It should be noted that, in the call by the CPU 13 to the CPU 6 constituting the step (103), predetermined addresses in the read data region of the page P0 are specified and, in response thereto, the respective first to fourth data D1, D2, D3 and D4 are transmitted from the CPU 6 of the lens device 1 to the CPU 13 of the camera body 2. Therefore, in the step (104), information characteristic of the lens device 1 actually in use, such as, the focal length, aperture ratio, presence or absence of the automatic control unit 7, and the number of motors included in the drive means 4, is fetched into the CPU 13 of the camera body 2.

In response to the reception in the CPU 13 of the initial data from the CPU 16, the initial conditions of the various circuits in the camera body 2 are suitably set in the step (105) so as to accommodate such circuits to the characteristics of the lens device 1 mounted on the camera body 2. In the following decision step (106), it is determined whether or not the initial setting of the circuits in the camera body 2 has been completed. If not, the

program returns to the step (103) for calling upon the CPU 6 either to resend the initial data, or to send further initial data to the CPU 13. If the initial setting of the circuits in the camera body 2 is determined to be completed in the step (106), the program advances to the step (107) in which the image projected through the lenses 31 is picked up by the imaging element 8, and the resulting video signal is supplied through the processing circuit 10 to the sensing circuit 12. In the next step (108), the sensing circuit 12 senses the optical conditions of the projected image from the corresponding video signal, and the resulting condition sensing signals SD supplied by the sensing circuit 12 are received by the CPU 13. Thereupon, in the step (109) the CPU 13 takes from the selector switches 15 the selected further adjustment signals SH which, for example, indicate a zoom setting (zooming number) or the like desired by the operator of the camera 100.

In response to the condition sensing signals SD received from the sensing circuit 12 and the selected function adjustment signals SH received from the selecting switches 15, the CPU 13 of the camera body 2 generates a corresponding position control signal SL which is transmitted to the CPU 6 in the step (110). This position control signal SL specifies prescribed addresses of the write data region of the page P1 for operating the one of the drive motor M1 to M4 associated with the function to be adjusted. Thus, the CPU 6, in the step (111), suitably drives and controls a motor of the drive means 4, for example, for adjusting the positions of the iris blades of the diaphragm mechanism 3i, or for adjusting the positions of the lenses 31.

During the operation of one or more of the motors of the drive means 4 under the control of the CPU 6 in response to the position control signal SL, the sensors 5 continuously detect the changing positions of the respective movable elements of the lens assembly 3 and corresponding sensed position signals SS are returned by the CPU 6 to the CPU 13. In the event that the movable elements of the lens assembly 3 to be driven do not, in fact, move in accordance with the position control signal SL transmitted to the CPU 6 in the step (110), for example, if the drive means 4 or the mechanism for manually adjusting a function of the lens assembly 3 is jammed, this fact is determined in the step (113). More specifically, if it is determined in the step (113) that the lenses 31 or the movable iris blades have not moved properly in response to the position control signal SL, the CPU 13 transmits a suitable signal SL to the CPU 6 for halting the operation of the drive means 4 and further actuates a suitable alarm in the step (114). Therefore, excess mechanical stressing and possible damage to the drive means 4 or other structures are avoided if the drive means 4 or the movable elements of the lens assembly 3 are, for any reason, jammed or otherwise rendered immovable.

On the other hand, if the movements of the lenses 31 and of the iris blades proceed properly in response to the position control signal SL, the program advances from the step (113) to the step (115) in which sensed position signals SS are transmitted from the CPU 6 to the CPU 13 which, in the step (116), is also receiving current condition sensing signals SD from the sensing circuit 12. In response to this, the CPU 13 determines, in the step (117), whether, on the basis of the most recently received sensed position signals SS from the CPU 6, the current condition sensing signals SD from the sensing circuit 12 and the selected functional adjustment signals SH previously supplied from the selector switches 15, any further adjustment of the lens assembly 3 is required. If no further adjustment is required, that is, if the condition of the image projected on the imaging element 8 precisely corresponds to the positioning of the adjustable elements of the lens assembly 3 called for by the position control signals SL, the program advances to its terminal step (118) at which the movable element or elements of the lens assembly 3 are fixed. However, if it is determined by the CPU 13 in the step (117) that further adjustment is required, the program is returned to the step (107) and the subsequent steps are repeated until finally, no further adjustment is required. Thus, by the transmission of the signals SL and SS between the CPUs 6 and 13, adjustments of the various functions of the lens assembly 3, such as focusing, exposure and zooming adjustments are effected.

It will be seen that the provision of microprocessors or CPUs 6 and 13 in both the lens device 1 and the camera body 2 makes it possible to transmit between the camera body 2 and the lens device 1, signals SL and SS that merely indicate the extent of the desired adjustment of the function of the lens assembly 3 and the position thereof. Such signals are to be contrasted with signals for directly driving and controlling the drive motors included in the lens device 1. Moreover, by including the CPU 6 in the lens device 1 for actually controlling the motors of the drive means 4 therein, it is possible to effect the optimum drive control suited to the characteristics of the drive means 4 or the weight of the lens assembly 3 in the respective lens device 1, which may vary substantially from other lens devices 1 intended for use with the camera body 2.

Claims

1. An interchangeable lens device (1) comprising:
imaging lens means (3) having elements (31, 3i) which are controllable for adjusting respective functions thereof;
drive means (4) for each of said functions and operative to drive the respective controllable elements (31, 3i);
characterized by:
sensing means (5) for sensing the positions of said controllable elements (31, 3i) established by the respective drive means (4) and for supplying corresponding position information; and
signal processing means (6) operative to control said drive means (4) in response to externally applied position control signals, and to supply sensed position signals to the outside of the lens device (1) in response to said position information.

2. A device (1) according to claim 1 further comprising optical transmission means (19, 20) for receiving said externally applied position control signals and for emitting said sensed position signals.

3. A device (1) according to claim 1 wherein said elements (31, 3i) include an assembly of lens elements (31) movable axially relative to each other for changing the focal length and focal position of said assembly (1) as said functions to be adjusted.

4. A device (1) according to claim 3 wherein said elements (31, 3i) further include adjustable diaphragm members (3i) for effecting exposure adjustment as one of said functions to be adjusted.

5. A camera (100) comprising:
an interchangeable lens device (1) including imaging lens means (3) having elements (31, 3i) which are controllable for adjusting respective functions thereof, and drive means (4) for each of said functions and operative to drive the respective controllable elements (31, 3i);
characterized in that said lens device (1) further comprises:
sensing means (5) for sensing positions of said controllable elements (31, 3i) established by the respective drive means (4) and providing corresponding position information, and first signal processing means (6) operative to control said drive means (4) in response to externally applied position control signals and to provide sensed position signals to the outside of the lens device (1) in response to said position information;
and by:
a main body (2) on which said lens device (1) is removably mounted and including second signal processing means (13) operative to receive said sensed position signals provided by said first signal processing means (6) and to supply said externally applied position control signals to said first signal processing means (6).

6. A camera (100) according to claim 5 wherein said lens device (1) and said main body (2) have optical transmission means (19, 20) which cooperate for transmitting said sensed position signals and said position control signals therebetween when said lens device (1) is mounted on said main body (2).

7. A camera (100) according to claim 5 wherein said main body (2) further includes a source of vertical synchronizing signals (10), and said first and second signal processing means (6, 13) effect transmission of said position control signals and said sensed position signals therebetween in synchronism with said vertical synchronizing signals.

8. A camera (100) according to claim 7 wherein said transmission of the position control signals and the sensed position signals is effected intermittently, and said drive means (4) are operated to drive said respective controllable elements (31, 3i) of said lens device (1) only during intervals between successive intermittent transmissions of said position control and sensed position signals.

9. A camera (100) according to claim 5 wherein said main body (2) further includes imaging means (8) for deriving a video signal corresponding to an image projected onto said imaging means (8) by said lens means (3), means (12) responsive to said video signal for supplying to said second signal processing means (13) condition sensing signals characteristic of respective conditions of said image projected on said imaging means (8), and manually actuable selector means (15) for provided selected function adjustment signals to said second signal processing means (13), said second signal processing means (13) determining said position control signals applied externally to said first signal processing means (6) on the basis of said selected function adjustment signals and said condition sensing signals in addition to said sensed position signals.

10. A camera (100) according to claim 9 wherein said first signal processing means (6) stores information identifying the respective said lens device (1) and characteristics of the latter, and said sensed position signals supplied from said first signal processing means (6) to said second signal processing means (13) contain said information identifying the respective said lens device (1) and said characteristics thereof.

11. A camera (100) according to claim 9 wherein said controllable elements (31, 3i) of the imaging lens means (3) include an assembly of relatively axially movable lens elements (31) for changing the focal length and focal position of said assembly (3) as said functions to be adjusted, and

said condition sensing signals are characteristic of the focused condition of said image projected onto said imaging means (8).

12. A camera (100) according to claim 9 wherein said controllable elements (31, 3i) of said imaging lens means (3) include adjustable diaphragm members (3i) for effecting exposure adjustment as said function to be adjusted, and said condition sensing signals are characteristic of the amount of light included in said image projected onto said imaging means (8).

13. A camera (100) according to claim 5 wherein said lens device (1) further includes automatic control means (7) connected with said first signal processing means (6) for adjusting said respective functions of the imaging lens means (3).

14. A camera (100) comprising:
a main body (2) including an imaging element (8) operative to provide a video signal corresponding to an image projected onto said element (8), means (12) responsive to said video signal for providing condition sensing signals corresponding to respective conditions of said image projected on said imaging element (8), manually actuable selector means (15) for providing selected function adjustment signals, and main body signal processing means (13) receiving said condition sensing signal and said selected function adjustment signals; and
interchangeable lens devices (1) interchangeably mountable on said main body (2) and each including imaging lens means (3) for projecting said image onto said imaging element (8) and having elements (31, 3i) which are controllable for adjusting respective functions of said imaging lens means (3), and drive means (4) for each of said adjustable functions and operative to drive the respective controllable elements;
characterized by:
the lens devices (1) further each including sensing means for sensing positions of said controllable elements (31, 3i) established by the respective drive means (4) and providing corresponding position information, and auxiliary signal processing means (6) storing information identifying the respective lens device (1) and characteristics thereof, and being operative to supply to said main body signal processing means (13) sensed position signals corresponding to said position information and the stored identifying information; and
said main body signal processing means (13) being responsive to said condition sensing signals, said selected function adjustment signals and said sensed position signals to supply position control signals to said auxiliary signal processing means (6) for causing it correspondingly to control said drive means (4).

15. A camera (100) according to claim 14 wherein each of said lens devices (1) and said main body (2) have optical transmission means (19, 12) which cooperate for transmitting said sensed position signals and said position control signals therebetween when said lens device (1) is mounted on said main body (2).

16. A camera (100) according to claim 14 wherein said main body (2) further includes a source (10) of vertical synchronizing signals, and said main body (2) and said auxiliary signal processing means (13) effect transmission of said position control signals and said sensed position signals therebetween in synchronism with said vertical synchronizing signals.

17. A camera (100) according to claim 16 wherein said transmission of the position control signals and the sensed position signals is effected intermittently, and said drive means (4) are operated to drive said respective controllable elements (31, 3i) of said lens device (1) only during intervals between successive intermittent transmission of said position control and sensed position signals.

18. A camera (100) according to claim 14 wherein each said lens device (1) further includes automatic control means (17) connected with said auxiliary signal processing means (6) and through which said drive means (4) are controlled by said automatic control means (6) for adjusting and respective functions of the imaging lens means (3).

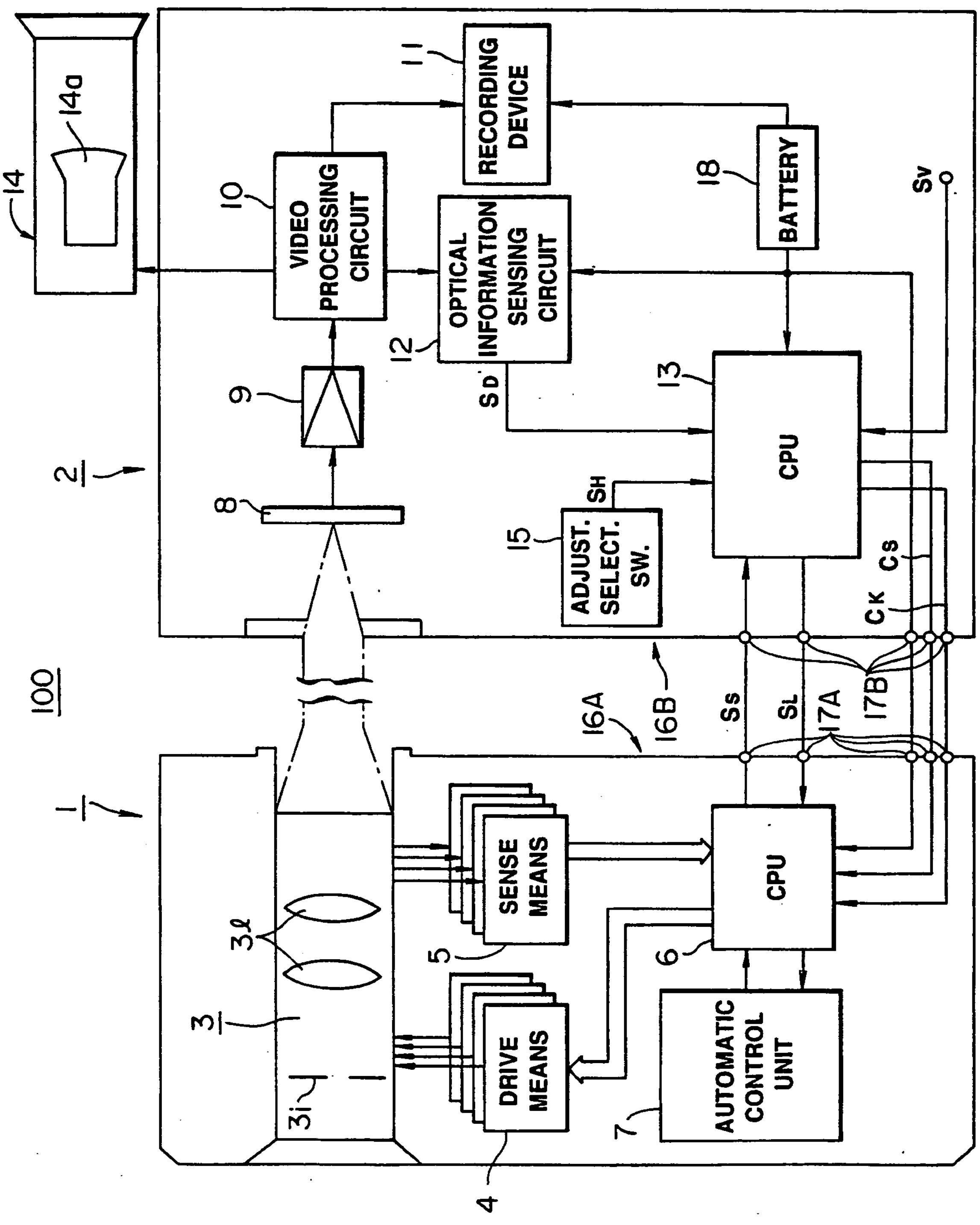

100
1
2
3
3ℓ
3i
4
DRIVE MEANS
5
SENSE MEANS
6
CPU
7
AUTOMATIC CONTROL UNIT
8
9
10
VIDEO PROCESSING CIRCUIT
11
RECORDING DEVICE
12
OPTICAL INFORMATION SENSING CIRCUIT
13
CPU
14
14a
15
ADJUST. SELECT. SW.
16A
16B
17A
17B
18
BATTERY
SD
SH
SV
SS
SL
CK
CS

FIG.1

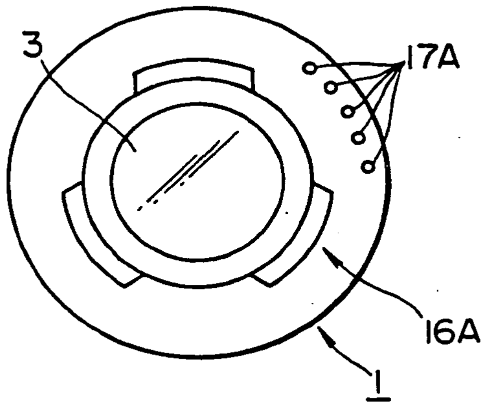


FIG.2A

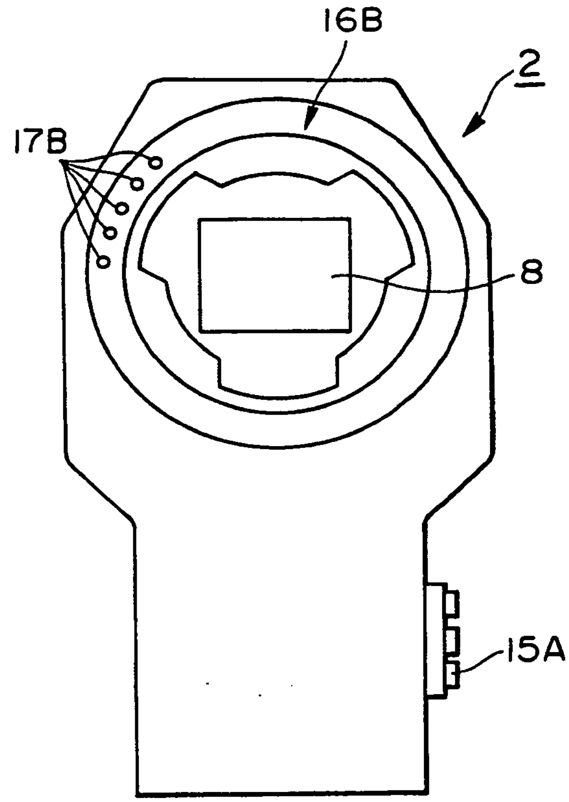


FIG.2B

FIG.4A

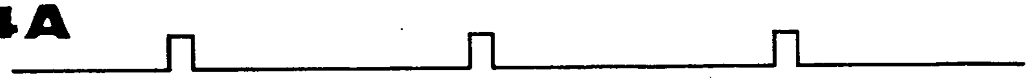
Sv 

FIG.4B

Cs 

FIG.4C

CK 

FIG.4D

SL OR Ss 

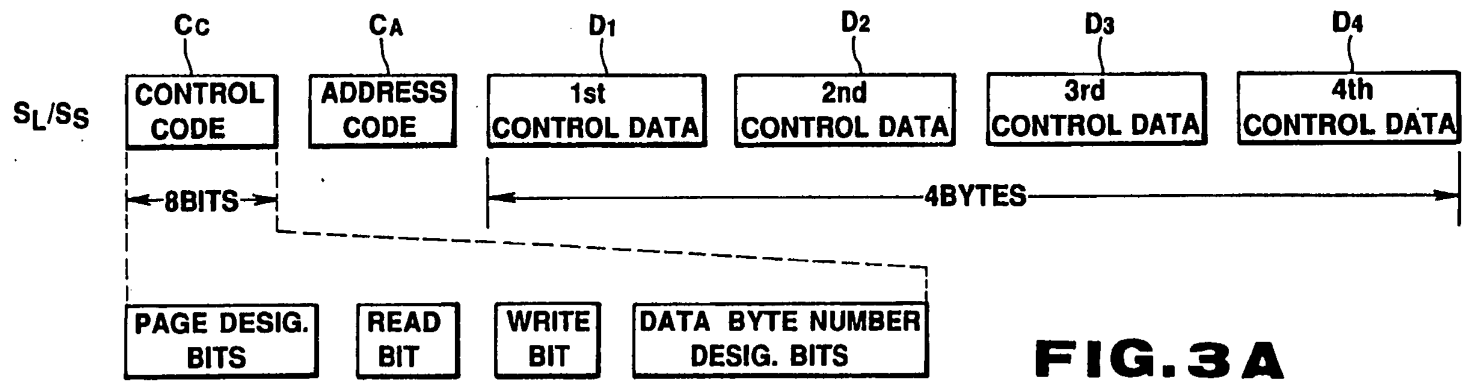


FIG. 3A

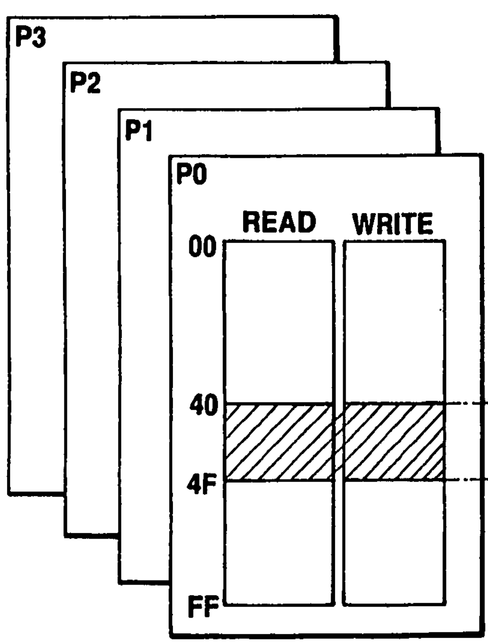


FIG. 3B

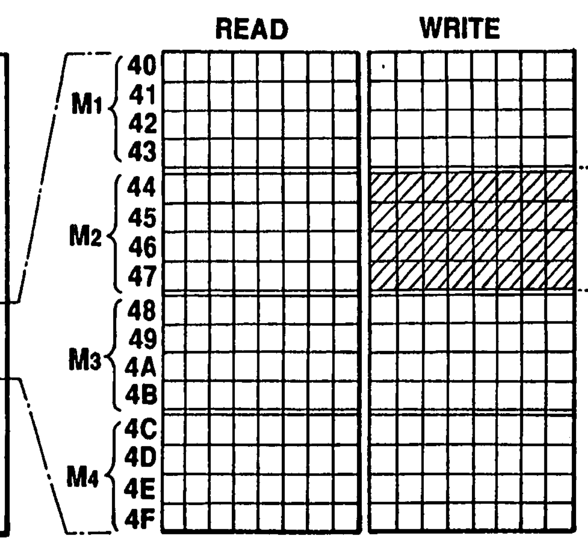


FIG. 3C

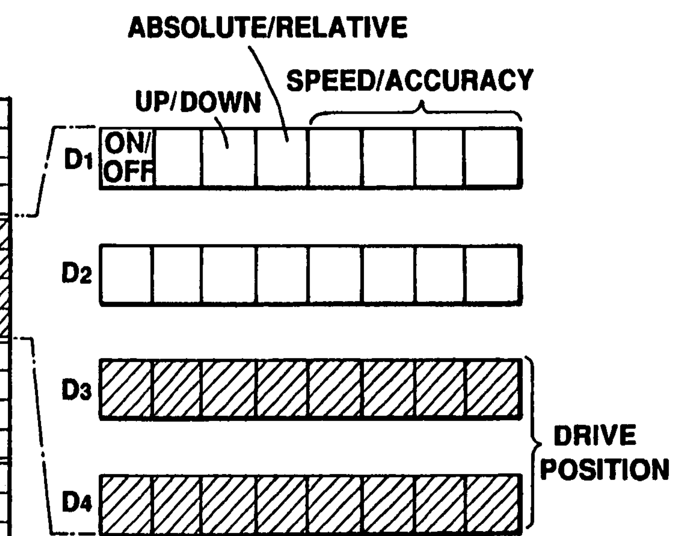


FIG. 3D

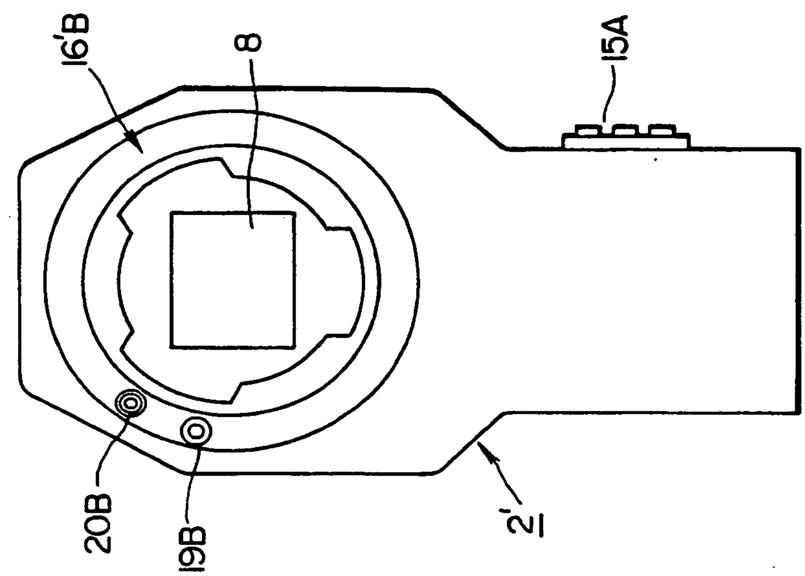


FIG.5B

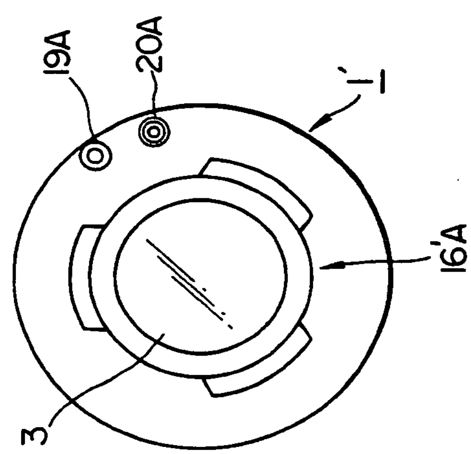


FIG.5A

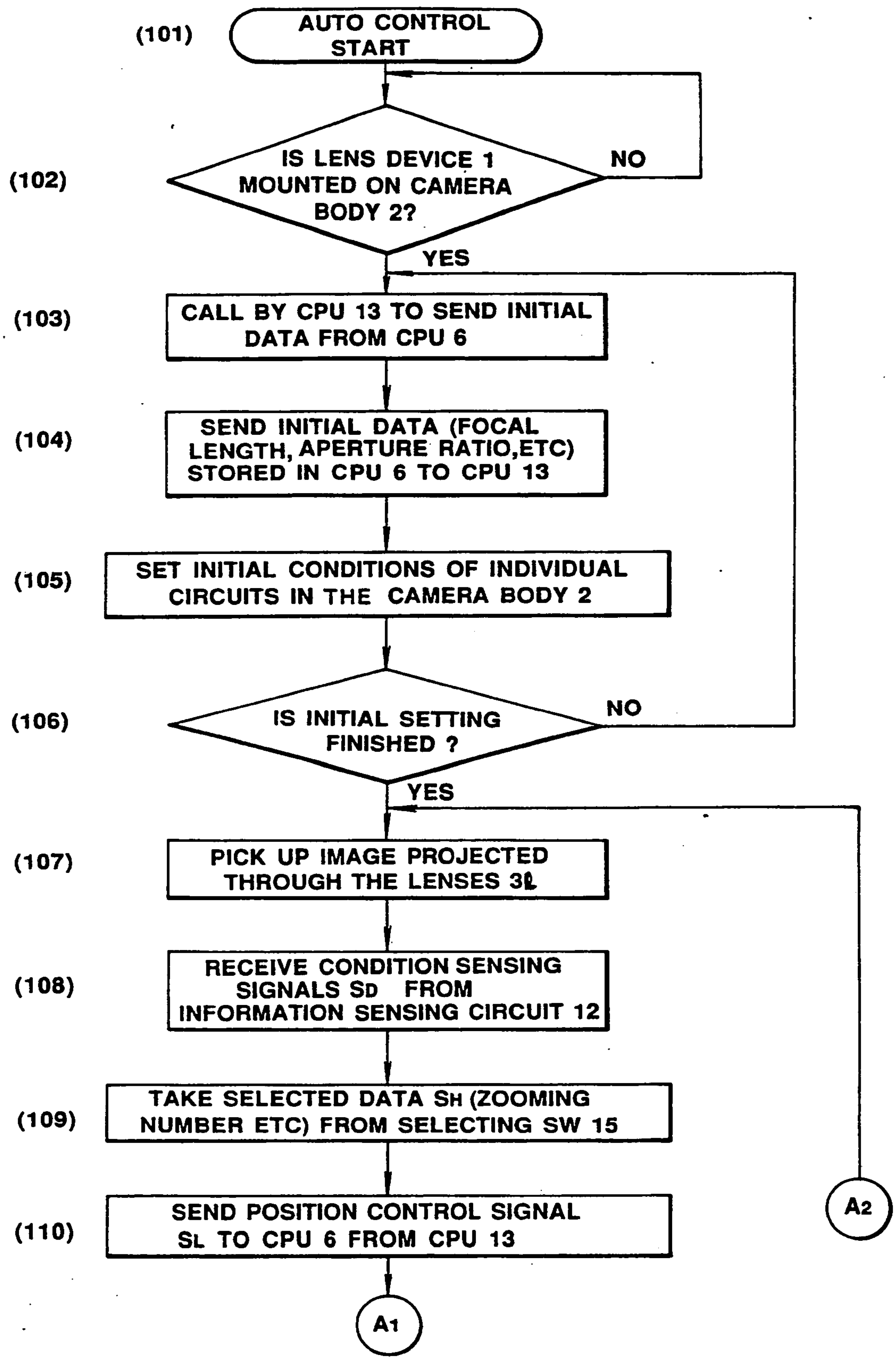

(101)
AUTO CONTROL START
(102)
IS LENS DEVICE 1 MOUNTED ON CAMERA BODY 2?
NO
YES
(103)
CALL BY CPU 13 TO SEND INITIAL DATA FROM CPU 6
(104)
SEND INITIAL DATA (FOCAL LENGTH, APERTURE RATIO,ETC) STORED IN CPU 6 TO CPU 13
(105)
SET INITIAL CONDITIONS OF INDIVIDUAL CIRCUITS IN THE CAMERA BODY 2
(106)
IS INITIAL SETTING FINISHED ?
NO
YES
(107)
PICK UP IMAGE PROJECTED THROUGH THE LENSES 3ℓ
(108)
RECEIVE CONDITION SENSING SIGNALS SD FROM INFORMATION SENSING CIRCUIT 12
(109)
TAKE SELECTED DATA SH (ZOOMING NUMBER ETC) FROM SELECTING SW 15
(110)
SEND POSITION CONTROL SIGNAL SL TO CPU 6 FROM CPU 13
A2
A1

FIG.6A

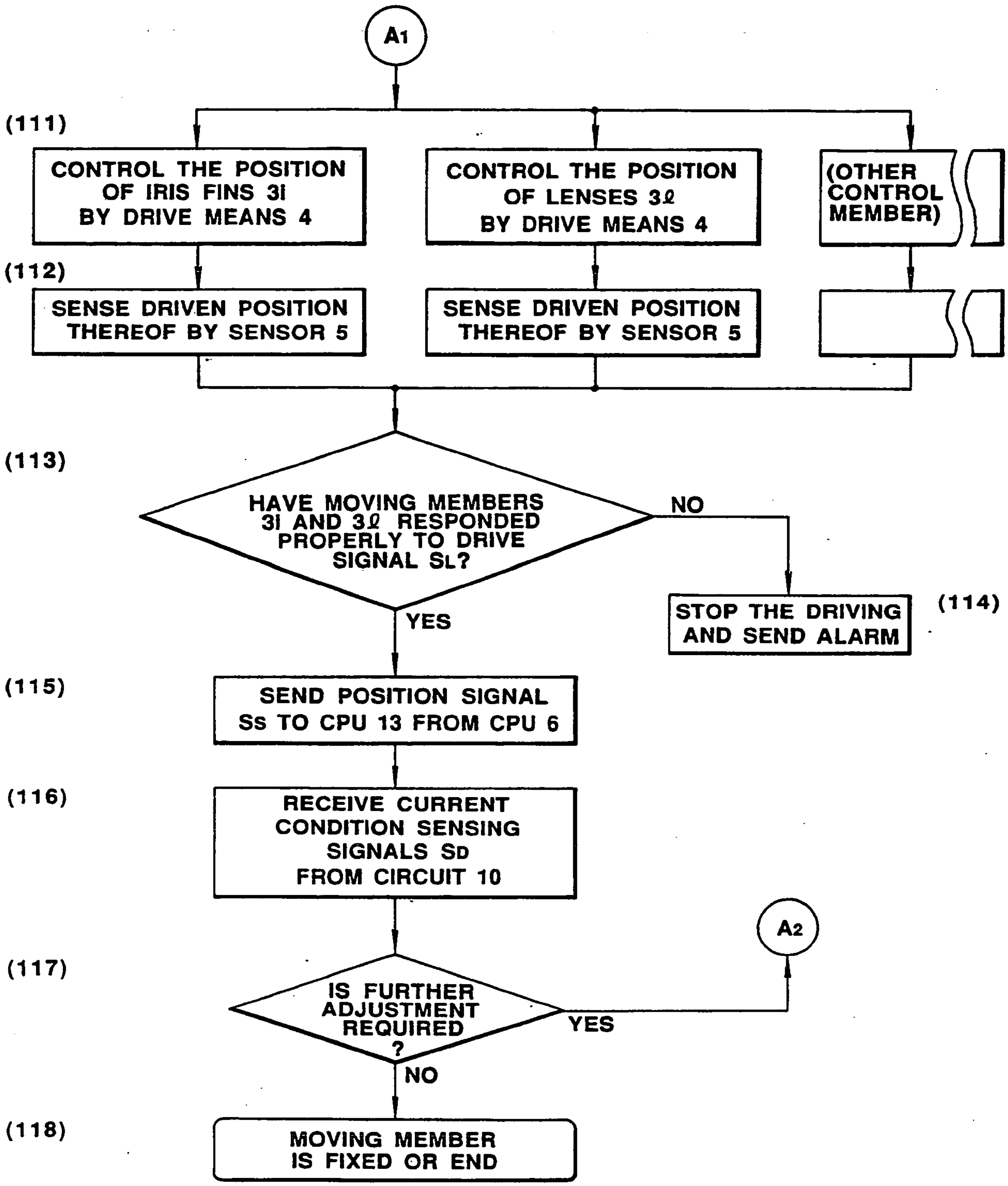

A1
(111)
CONTROL THE POSITION OF IRIS FINS 3I BY DRIVE MEANS 4
CONTROL THE POSITION OF LENSES 3ℓ BY DRIVE MEANS 4
(OTHER CONTROL MEMBER)
(112)
SENSE DRIVEN POSITION THEREOF BY SENSOR 5
SENSE DRIVEN POSITION THEREOF BY SENSOR 5
(113)
HAVE MOVING MEMBERS 3I AND 3ℓ RESPONDED PROPERLY TO DRIVE SIGNAL SL?
NO
YES
STOP THE DRIVING AND SEND ALARM
(114)
(115)
SEND POSITION SIGNAL Ss TO CPU 13 FROM CPU 6
(116)
RECEIVE CURRENT CONDITION SENSING SIGNALS SD FROM CIRCUIT 10
A2
(117)
IS FURTHER ADJUSTMENT REQUIRED ?
YES
NO
(118)
MOVING MEMBER IS FIXED OR END

FIG.6B